

APPARATUS AND METHOD FOR DISPENSING SHEET MATERIAL

BACKGROUND OF THE INVENTION

5 The present invention relates to the dispensing of sheet material.
More specifically, the invention relates to an apparatus for dispensing
predetermined lengths of sheet material.

 Sheet material dispensers for dispensing, for example, but not by
way of limitation, paper towels, generally include a housing, and a supply of
10 sheet material within the housing in the form of individual sheets, folded
sheets, festooned sheets, or a roll of sheet material which can be dispensed
as individual sheet materials, such as, for example only, paper towels. Roll
towel dispensers typically include a mechanism for advancing sheets or
unrolling the sheet material roll. In some dispensers, the mechanism
15 includes a lever or a crank for manually dispensing sheet material from the
roll, and the dispenser housing often carries a blade for cutting the lengths
of sheet material from the roll. Manual contact with a dispenser lever or one
or more sheets touched by another user can be a health hazard for a user,
especially in certain environments such as, by way of non-limiting example,
20 in hospitals, and so forth.

 Further, another disadvantage of sheet dispensers is that the
softness and absorbency characteristics of the sheet material, or lack
thereof, are limited by the mechanical and/or electrical limitations of the
dispenser. That is, the dispenser has a predetermined setting which
25 provides the same amount of sheet material to a user, whether or not the
sheet material is a soft, highly absorbent sheet material, or whether the
sheet material has a much lower absorbency.

 A sheet material which is soft and highly absorbent only requires, for
example, about eleven to twelve inches, or less, of sheet material per hand
30 drying even to sufficiently dry a user's hands to the user's satisfaction. A
sheet which is not highly absorbent may require fourteen inches, eighteen

inches, or more to sufficiently dry a user's hands to the user's satisfaction. When a dispenser is preset to dispense, for example, about twelve inches of sheet material, it may satisfy a user if highly absorbent. However, if the sheet material is low absorbency, it will likely result in the user obtaining at
5 least another twelve (12) inch sheet. This results in waste, higher costs to maintain sheet material in the dispenser, and a greater environmental impact.

Some dispensers allow a change in length of the sheet material dispensed by a manual manipulation of the dispenser prior to the
10 introduction of a new roll of sheet material. A disadvantage with these dispensers is that they require an operator to manually adjust the sheet material length during replacement of a roll. Apart from requiring time, effort and expertise from the operator, there is the risk of human error in the resetting operation.

15 Accordingly, there remains a need in the art for a sheet material dispenser which automatically dispenses different lengths of sheet material based on characteristics of the sheet material, such as absorbency, and so forth. Desirably, such a sheet material dispenser would recognize the sheet material, and would dispense an appropriate amount in one sheet to satisfy
20 a user's hand drying needs, but limit cost and waste.

SUMMARY OF THE INVENTION

The present invention provides a sheet material dispenser which controls the lengths of sheet material dispensed from a continuous roll
25 by identifying the type of sheet material on the roll and dispensing suitable lengths of the identified sheet material. The dispenser desirably may include a support for supporting sheet material carrying identification relating to the type of sheet material, and an identifier in or adjacent the dispenser for identifying the type of sheet material. A
30 processor receives data from the identifier, processes the data and generates an output command, and a controller controls the lengths of

sheet material dispensed from the roll in response to the output command. In this way, more absorbent products can be dispensed in shorter lengths and less absorbent products in longer lengths.

The identifier may be a reader or scanner which reads data from
5 identification on the sheet material or on a core of the sheet material roll. In this case, the identification may comprise a label, a logo, a bar code, a magnetic strip, a radio frequency identification device (RFID) such as a "smart" tag or chip, or a hologram on the roll of sheet material. Desirably, the identification on the roll of sheet material is encoded, and the dispenser
10 includes a decoder for decoding the encoded data.

Alternatively, the identifier may comprise an infrared emitter/detector circuit which is arranged to emit infrared light into the core of the sheet material roll, and to detect reflection of the light off reflective identification on the core of the roll.

15 The broad scope of the applicability of the present invention will become apparent to those of skill in the art from the details given below.

The detailed description of the preferred embodiments of the invention is given by way of example only, and various modifications within the scope of the invention will be apparent to those of skill in the art.

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BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view, partially in cross-section, of a sheet material dispenser according to an embodiment of the present invention.

FIG. 2 is a front view of a portion of the dispenser of FIG. 1 in an
25 open condition.

FIG. 3 is a cross-sectional view along the line 3-3 in FIG. 2.

FIG. 4 is a block diagram of the dispenser illustrated in FIG. 1.

FIG. 5 is a cross-sectional view of a portion of a dispenser according to a another embodiment of the invention.

30 FIG. 6 is a perspective view of a portion of a dispenser according to a still another embodiment of the invention;

FIG. 7 is a front view of a portion of the dispenser of FIG. 1 in an open condition, showing a module which is inserted into the dispenser housing of the present invention;

FIG. 8 is a block diagram of yet another embodiment of the present invention;

FIG. 9 is a logic chart of a dispense paper routine;

FIG. 10 is a logic chart of a check dispenser status routine;

FIG. 11 is a logic chart of a paper routine; and

FIG. 12 is a block diagram of still yet another embodiment of the present invention.

DEFINITIONS

As used herein, the term "identification" when used as a noun means anything on an object which serves to identify the object.

As used herein, the term "identifier" means a mechanism or a device for identifying an object from identification on the object.

As used herein, the term "comprising" is intended to be inclusive or open-ended, and is not intended to exclude additional elements or method steps which do not prevent operation of the invention.

As used herein, the term "fasteners" means devices that fasten, join, connect, secure, hold, or clamp components together. Fasteners include, but are not limited to, screws, nuts and bolts, rivets, snap-fits, tacks, nails, loop fasteners, and interlocking male/female connectors, such as fishhook connectors, a fish hook connector includes a male portion with a protrusion on its circumference. Inserting the male portion into the female portion substantially permanently locks the two portions together.

As used herein, the term "basis weight" (hereinafter may be referred to as "BW") is the weight per unit area of a sample and may be reported as grams per meter squared (gsm). The basis weight may be measured using test procedure ASTM D 3776-96 or TAPPI Test Method T-220.

As used herein, the term "hinge" refers to a jointed or flexible device that connects and permits pivoting or turning of a part to a stationary component. Hinges include, but are not limited to, metal pivotable connectors, such as those used to fasten a door to frame, and
5 living hinges. Living hinges may be constructed from plastic and formed integrally between two members. A living hinge permits pivotable movement of one member in relation to another connected member.

As used herein, the term "couple" includes, but is not limited to, joining, connecting, fastening, linking, or associating two things integrally
10 or interstitially together.

As used herein, the terms "sheet material" and "paper" means a material that is thin in comparison to its length and breadth. Generally speaking, sheet materials should exhibit a relatively flat planar configuration and be flexible to permit folding, rolling, stacking, and the
15 like. Exemplary sheet materials and papers include, but are not limited to, paper tissue, bath/toilet tissue, paper towels, wipes, label rolls, or other fibrous, film, polymers, or filamentary products. The terms "sheet material" and "paper" may be used interchangeably.

These terms may be defined with additional language in the
20 remaining portions of the specification.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to one or more embodiments of the invention, examples of which are illustrated in the drawings. Each
25 example and embodiment is provided by way of explanation of the invention, and is not meant as a limitation of the invention. For example, features illustrated or described as part of one embodiment may be used with another embodiment to yield still a further embodiment. It is intended that the invention include these and other modifications and variations as
30 coming within the scope and spirit of the invention.

FIG. 1 of the drawings illustrates a dispenser **10** for dispensing a web of sheet material **12** from a continuous roll **14** according to one embodiment of the present invention. The web of sheet material in this embodiment comprises an absorbent material, such as paper towelling, and so forth,
5 which may be periodically perforated for separation.

With reference also to FIG. 2 of the drawings, the dispenser **10** is seen to include a dispenser housing **16** having a back panel **18** mountable to a wall or similar vertical surface, a pair of opposed side panels **20** and **22**, and a front cover **24**. The front cover **24** is desirably, but not by way of
10 limitation, pivotally connected to a lower portion of the housing **16** with hinges **28** so as to be movable between a closed condition, as illustrated in FIG. 1, and an open condition, as illustrated in FIG. 2. It will be appreciated that the front cover **24** may be connected by fasteners, screws, and any other mechanism known in the art. The front cover **24** of the dispenser
15 housing **16** typically is opened for servicing or for loading a replacement sheet material roll into the dispenser **10**. A latch (not shown) allows the front cover **24** to be locked in the closed condition so as to avoid unauthorised tampering with the dispenser components within the housing **16**.

20 The sheet material roll **14** desirably includes a core or sleeve **30**. The sheet material roll **14** may, alternatively, be a coreless roll, such as that disclosed in U.S. Patent No. 5,620,148 to J. Mitchell, which is hereby incorporated by reference in its entirety herein for all purposes. The sheet material roll **14** is desirably rotatably supported within the housing **16** by a
25 pair of mounting hubs **32** and **34** which, in the present embodiment, are illustrated as connected to the side panels **20** and **22** of the housing **16** by means of roll holders **36** and **38**. It will be appreciated, however, that the housing **16** may be provided as a separate unit with few or no mechanisms connected thereto. In this instance, some or all of the dispensing
30 mechanisms shown and/or described herein may be provided as one or more modules which are inserted into the housing, as illustrated in FIG. 7.

Examples of such dispenser housings and modules are disclosed in U.S. Patent Nos. 4,131,044 and 6,079,035, both of which are incorporated by reference in their entirety herein for all purposes.

As can be seen, the sheet material **12** runs off the roll **14**, between a
5 pair of rollers **40** and **42**, and through a dispensing opening **44**, for example, in a lower end **45** of the housing **16**. Alternatively, the dispensing opening may be formed in the front cover, or in both a portion of the front cover and a portion of the lower end (not shown). The opening **44** may have a serrated edge (not illustrated), or it may carry teeth (also not illustrated) for
10 severing the web of sheet material. One end of the roller **40** may be rotatably mounted to the side panel **20** of the housing **16** or of a module housing (FIG. 7) by means of a roll holder **46**, and one end of the roller **42** may be rotatably mounted to the side panel **20** of the housing **16** or of a module housing (FIG. 7) by means of a roll holder **48**. The other ends of
15 the rollers **40** and **42** may be rotatably mounted to the side panel **22** by means of roll holders concealed within a transmission housing **50**. The transmission housing **50** contains a transmission (not visible) for transmitting drive from an electric motor **52** to the roller **40** so as to rotate this roller. Alternatively, at least one of the rollers may be mounted in the
20 front cover, as disclosed generally in U.S. Patent No. 6,607,160 which is incorporated by reference in its entirety herein for all purposes.

The rollers **40** and **42** together define a nip **54** having a gap which is desirably slightly smaller than the thickness of the sheet material on the roll **14**. The sheet material **12** passes through the nip **54**, as shown most
25 clearly in FIG. 1, so that rotation of the drive roller **40** and the driven roller **42** pulls the sheet material off of the roll **14** and dispenses it through the dispensing opening **44**.

An activation sensor **56** may be mounted to the lower end **45** of the housing **16** (or, alternatively, to a module in the housing (not shown))
30 adjacent a lens **58**, as illustrated in FIG. 1. It will be understood, however, that the activation sensor **56** and/or lens **58**, or any activations system

shown and/or described herein or known in the art, may be mounted in any area of the housing, so long as it operates as described herein. In this embodiment of the invention, the sensor **56** is desirably, but not by way of limitation, a conventional passive sensor for detecting infrared radiation.

5 Passive infrared detectors are known in the art, and are described, for example, in U.S. Pat. No. 4,757,337 to Shikaumi and U.S. Pat. No. 4,960,248 to Bauer *et al*, both of which are incorporated herein by reference. A passive infrared detector which may be used with the dispenser **10** is a Model 40623 sold by Eltec Instruments Inc. However,
10 those of skill in the art will appreciate that various different infrared detectors are available, and that many of the available detectors are suitable for use with the dispenser **10**. In practice, the sensor **56** is arranged to detect infrared radiation from a user's hand placed below the lens **58**, and upon detecting the radiation, to transmit a signal for activating the electric motor
15 **52** so as to dispense a length of sheet material through the dispensing opening **44**.

It will be understood, however, that other activation mechanisms, such as capacitive and ultrasonic, may be used in the present invention. Capacitive proximity sensors produce an electrostatic field that will sense
20 both metal objects and non-metallic materials such as paper, glass, liquids and cloth. Ultrasonic proximity sensors use a transducer to send and receive high frequency sound signals. When a target enters the beam the sound is reflected back to the sensor, causing it to energize or de-energize the output circuit. Another sensor type is inductive. In this case an
25 electromagnetic field is used, however, detection is limited to only metallic objects.

With particular reference now to FIG. 3 of the drawings, the dispenser **10** includes a reader or scanner **60** positioned in a non-limiting example on the housing **16** or module (FIG. 7), and by way of another non-
30 limiting example, the core **30** of the roll **14** carries identification in the form of a Radio Frequency Identification Device (RFID), which in this

embodiment comprises a passive "smart" chip or tag **62**. It will be understood that the reader or scanner **60** may be positioned on any portion of the dispenser, or near the dispenser, which permits it to operate in the manner shown and described herein. Similarly, it will be appreciated that
5 the smart tag **62** may be positioned on any location, or a number of locations, on the sheet material.

The smart tag **62** contains information relating to the type of sheet material on the roll **14**, for example information relating to the absorbency, the basis weight, etc. of the sheet material **12**. In use, the scanner **60**
10 interrogates the smart tag **62** with an electronic signal, and the smart tag **62**, which includes an internal antenna (not visible), in turn generates and transmits an electromagnetic pulse that is readable by the scanner to identify the type of sheet material on the roll **14**. The scanner **60** typically is configured to retrieve information from the smart tag **62** and to decode the
15 information.

RFID smart tag technology is known and understood by those skilled in the art, and a detailed explanation thereof is not necessary for purposes of describing the dispenser and method of the present invention.

Generally, conductive or passive smart tags consist of silicone or other
20 semiconductors, a coiled, etched, or stamped antenna, a capacitor, and a substrate on which the components are mounted or embedded. A protective covering typically is used to encapsulate and seal the substrate.

Inductive or passive smart tags have been introduced by Motorola under the name BISTATIX[®]. A detailed description of the BISTATIX[®] device
25 may be found in U.S. Pat. No. 6,259,367 to Klein, the entire contents of which is incorporated herein by reference. Further information on smart tags and related technology is disclosed in U.S. Pat. No. 6,451,154 to Grabau *et al*; U.S. Pat. No. 6,354,493 to Mon; U.S. Pat. No. 6,362,738 to Vega; and PCT publication WO 02/48955. Various different RFID tags
30 and scanners are available. RFID tags and scanners suitable for use with the dispenser **10** are available from, for example, Philips Semiconductors

of Eindhoven, The Netherlands; Sokymat of Lausanne, Switzerland; Checkpoint Systems Inc. of Miami, Florida; and Omron Company of Tokyo, Japan.

Alternatively, the smart tags **62** may be an active device. In this
5 configuration, the smart tag **62** includes active transceiving circuitry that has the capability to selectively respond to coded request signals transmitted by a scanner. An active smart tag **62** may include the capability to receive and store additional information beyond the information contained in its fixed code. An active smart tag **62** requires an
10 internal power supply, such as a micro-battery, thin film battery, and so forth (not shown).

The dispenser housing **16** desirably contains at least one battery **64** (see FIGS. **1** and **2**) for powering the various electric and electronic components within the dispenser **10**. It will be appreciated, however, that
15 more than one, that is, a plurality of batteries may be used. Alternatively, however, the dispenser may be powered by AC or an AC powered transformer adapter.

Referring now to FIG. **4** of the drawings, the dispenser **10** includes a processor **66** which receives data from the scanner **60** relating to the type of
20 sheet material on the roll **14**. The processor **66** contains an algorithm, which in this embodiment is stored in a chip set embedded on a printed circuit board within the dispenser housing **16**, and which is used to process the data from the scanner **60** and to generate an output command for a controller **68**. The controller in turn controls the operation of the electric
25 motor **52**, and hence the dispensing of the sheet material **12**, in a manner which is described in more detail below.

A delay switch **70** is desirably provided for ensuring a minimum delay of, for example, but not by way of limitation, three seconds between successive activations of the electric motor **52**. This delay is designed to
30 avoid accidental reactivation of the electric motor, and hence unnecessary dispensing of sheet material by a user. The dispenser **10** also desirably

includes a lockout switch **72** which opens when the front cover **24** is pivoted away from the closed condition, so as to prevent communication between the sensor **56** and the controller **68**. This prevents operation of the electric motor **52** while the dispenser **10** is open. When the front cover **24** is
5 returned to the closed condition, the lockout switch **72** automatically closes to allow operation of the controller **68** and the electric motor **52**. In this way, the switch **72** protects an operator from moving components within the housing **16** during servicing or replacement of the roll of sheet material.

An activation switch **74** closes when the front cover **24** is opened,
10 thereby desirably activating the scanner **60**. This allows the scanner to read information from the smart tag **62** when the roll **14** is inserted into the dispenser **10**. A deactivation switch **76** is also provided for deactivating the scanner **60**, to conserve energy, after a predetermined number of revolutions of the drive roller **40**, for example 9, or a predetermined number
15 of activations of the electric motor **52**, for example 3. It will be understood that any number of revolutions or activations may be set for the deactivation switch.

Alternatively, the dispenser **10** may be equipped with a reset system, e.g., a front cover **24** mounted switch that would trip when the front cover **24**
20 was opened for reloading (not shown). In another alternative, a switch could be provided in connection with a fuel gauge which would trip when the fuel gauge goes to a full zero positions, such as when a product roll is replaced (not shown). Once the system is reset, its reading or sensing circuit would be enabled for a discrete or limited increment, for example,
25 three rotations of the drive roller. After this interval and sensing of the product, the reading or sensing system would shut down until the next reset to conserve power. In still another alternative, a momentary contact switch may be provided in conjunction with, for example, one arm of the roll holder, such that movement of the arm, to load a new roll of sheet material,
30 energizes the reading or sensing circuit.

The operation of the dispenser **10** will now be described with reference to FIG. 4. First, upon opening the front cover **24** of the dispenser housing **16** for the replacement of the sheet material **12**, the activation switch **74** desirably closes to activate the scanner **60**. The scanner then

5 reads and decodes information relating to the type of sheet material **12** on the replacement roll **14** from the smart tag **62**, and transmits data relating to the type of sheet material to the processor **66**. The processor receives the data, processes the data, and generates an output command for adjusting the setting of the controller **68**, which in turn controls the electric motor **52**

10 so as to dispense a suitable length of sheet material. In this way, the lengths of sheet material **12** metered or dispensed vary according to the type of sheet material **12** on the roll **14**. For example, the dispenser **10** may be set to dispense three different types of sheet material **A**, **B** and **C** having different degrees of softness and absorbency. If the towel **A** is the most

15 absorbent and the towel **C** is the least absorbent, the processor **66** typically is set to generate output commands for adjusting the controller **68** so as to dispense shorter lengths of towel **A** than towel **C**. For example, the controller **68** may be adjustable to dispense 12 inches of sheet material **A**, 14 inches of sheet material **B**, and 18 inches of sheet material **C**. In this

20 way, higher quality, more absorbent sheet material is efficiently dispensed without significant waste, while lower quality, less absorbent sheet material is dispensed in sufficiently long lengths to effect proper drying of a user's hands. A desired result is to provide one sheet of material to dry a user's hands; the length provided is meant to provide adequate dryness, based on

25 characteristics of the sheet material, such as absorbency, basis weight, and so forth, so that a user only uses one sheet per hand drying episode.

Once the controller **68** has been set and the front cover **24** has been closed (and desirably locked), sheet material **12** is dispensed to a user upon triggering of the sensor **56**. In this regard, when the sensor **56** detects a

30 user's hand, it transmits a signal to the controller **68**, through the switches **70** and **72**, and the controller then activates the electric motor **52** to

dispense the predetermined length of sheet material to the user. In this embodiment of the invention, the controller **68** desirably includes a counter which limits the number of revolutions of the electric motor **52** to effect dispensing of the desired length of sheet material to the user. The delay
5 switch **70** is opened upon deactivation of the electric motor **52** by the controller **68**, and this switch remains open for a predetermined time interval, for example, but not by way of limitation, 3 seconds, to block communication between the sensor **56** and the controller **68**. In this manner, the delay switch **70** desirably prevents accidental reactivation of
10 the motor **52** by a user removing sheet material **12** from the dispenser **10**, and hence unnecessary dispensing of the sheet material. The delay switch **70** also serves to discourage vandals by frustrating bulk dispensing.

When an operator opens the front cover **24** to replace the roll **14**, the activation switch **74**, by way of non-limiting example, once again activates
15 the scanner **60** so as to allow for the reading of a smart tag on a replacement roll of sheet material inserted into the dispenser **10**. In the event that the replacement roll comprises a different sheet material to the previous roll, the processor **66** generates a new output command for adjusting the setting of the controller **68**, and hence the length of sheet
20 material to be dispensed by the electric motor **52**. Also, as soon as the front cover **24** of the dispenser housing **16** is opened, the lockout switch **72** opens to prevent operation of the electric motor **52**, thereby to protect the operator from moving components within the housing **16**.

In the event that an unrecognized roll of sheet material
25 ("unrecognized roll", "unrecognized sheet material" and/or "unrecognized paper" as used herein refers to a roll of sheet material which is scanned and either (1) does not send back the expected signal, or (2) does not send back any signal) is loaded into the dispenser **10**, and the scanner **60** is unable to read and/or receive information relating to the type of sheet
30 material on the roll, the processor **66** sets the controller **68** to a default setting, which typically is the last stored setting or the maximum setting,

which for sheet material **A**, **B** and **C** is 18 inches. In this way, when the dispenser **10** is used to dispense an unrecognized product, such as a product which the dispenser is not designed to dispense, it either dispenses the product at an arbitrary setting or at the maximum setting. Alternatively, the processor **66** may be designed to generate an output command in these instances which blocks operation of the controller **68** entirely so as to prevent operation of the electric motor **52**, and hence dispensing of sheet material. Such a function is advantageous because the use of an unrecognized product can result in the jamming of the dispenser or in unsatisfactory dispensing of the product.

FIG. 5 illustrates a portion of a dispenser **110** according to a second embodiment of the invention. In this embodiment, a support **112** for a sheet material roll **114** includes a pair of mounting hubs **116** and **118** connected to side panels **120** and **122** (or a mounting module, such as that shown in FIG.7) of a dispenser housing **124** by means of roll holders **126** and **128**. As can be seen, the roll **114** carries a reflective label **130**, and the support **112** includes an infrared emitter **132** in the mounting hub **116** and an infrared detector **134** in the mounting hub **118**. The emitter **132** is arranged to emit angled infrared light into the core of the roll **114**, as shown, which upon reflection off the reflective label **130** is detected by the infrared detector **134** to complete an infrared emitter/detector circuit. If an unauthorised product is inserted into the dispenser **110**, the infrared emitter/detector circuit will not be completed, and typically the dispenser will default to a setting in which a relatively long length of sheet material is dispensed. Recognition of different rolls of sheet materials in this embodiment may be accomplished by adjusting the relative reflectivity of the label and therefore total reflected light for various sheet materials. Apart from the infrared emitter/detector circuit, the dispenser **110** is similar in all other respects to the dispenser **10** described above.

In FIG. 6 of the drawings, a portion of a dispenser **210** according to a third embodiment of the invention is seen to include a reader **212** for

reading a logo **214**, a bar code or the like which may be typically stamped or ink-jetted onto a side of a sheet material roll **216**. It will be appreciated, however, that the bar code may be located anywhere on the roll **216**. The reader **212** in this embodiment is desirably located on a support arm **218** for
5 rotatably supporting the roll **216** within a dispenser housing **220**, and is positioned so as to be aligned with the path of travel of the logo **214**, although it will be appreciated that, like the bar code, the reader **212** may be positioned anywhere within the dispenser housing **216**, so long as it operates as described herein. Accordingly, as the roll **216** rotates on the
10 support arm **218**, the logo **214** passes the reader **212** to identify the roll. Once the type of sheet material has been identified, the dispenser **210** is automatically set to dispense a suitable length of the sheet material. If an unrecognized product without the required marking **214** is inserted into the dispenser **210**, a default setting typically will be assumed in which a
15 relatively long length of sheet material is dispensed. Apart from the support arms **218** and the reader **212**, the dispenser **210** is similar in all respects to the dispenser **10** described above.

It will be appreciated that the reader **212** may be configured to read and/or recognize a specific label, a specific logo, a magnetic strip, a
20 hologram, and so forth. Accordingly, the present embodiment is intended as a non-limiting example.

A portion of a dispenser **310** according to a fourth embodiment of the invention is illustrated in FIG. 7 of the drawings. The dispenser **310** is similar in many respects to the dispenser **10**, and differs only in that the
25 dispensing mechanisms are mounted in a module **311**, having, by way of non-limiting example, side walls **322** and at least a portion of a back wall **318**, which is inserted into the dispensing housing **316**. Otherwise, the dispenser **310** has the characteristics and operation of dispenser **10**, as previously described herein.

30 Referring now to FIG. 8, an alternative embodiment of a dispenser **10** controller **400** is presented. Controller **400** includes microprocessor or

microcontroller **402** ("microprocessor" and "microcontroller" used interchangeably herein) activation sensor **404** (comprising IR receiver **404a** and IR transmitter **404b**), paper type sensor **406**, motor **408**, relay **410** and various sensors, timers, adjustors, and LED indicators (described in more detail later). Controller **400** is powered by either A.C. power source **412** or D.C. power source **414**. A communication connection **416** is provided to facilitate programming/ reprogramming of microcontroller **402** and/or communication between dispenser **10** and a remote computer.

Microcontroller **402** controls the functioning of dispenser **10** by executing code stored in a program memory. Ideally, microcontroller **402** has onboard program memory and data memory. Such memory is desirably a non-volatile memory; however, volatile memory may be used. One example of a suitable microcontroller is the PIC16F72 microcontroller (PICmicro[®] family) manufactured by Microchip Technology.

Microcontroller **402**, motor **408** as well as individual components of controller **400** are powered by either A.C. power supply **412** or D.C. power supply **414**. Desirably, a 120 Volt A.C. line input voltage is reduced to 12 volts using a transformer. The reduced voltage is rectified and feed into linear regulator **413** which maintains the desired D.C. voltage level required by controller **10**. One possible embodiment of a D.C. power supply is a battery.

As previously noted for sensor **56**, activation sensor **404** is a conventional passive sensor for detecting infrared (IR) radiation comprising a transmitter **404a** and receiver **404b**. Such passive infrared detectors are known in the art. IR transmitter **404b** transmits a periodic (at random intervals or fixed intervals as desired) pulsed IR signal. IR receiver **404a** is configured to detect reflected IR signals in the same pattern as the transmitted signal. When such a signal is detected, activation sensor **404** generates an output signal informing microcontroller **402** that sheet material or paper should be dispensed.

Desirably, paper length adjustments and IR sensitivity adjustments are performed automatically over communication connection **416** using a remote computer. It should be noted, however, that dispenser **10** allows for manual paper length adjustments and manual IR sensitivity
5 adjustments using paper length adjustment **430** and IR sensitivity adjustments **418** respectively.

When microcontroller **402** determines that activation sensor **404** has been triggered and that dispenser **10** is ready to dispense paper, microcontroller **402** causes paper to be dispensed from dispenser **10** by
10 engaging relay **410** thereby applying power to electric motor **408**. As electric motor **408** turns, paper roll **14** turns and paper is forced out of the front of dispenser **10**. As paper is being dispensed, microcontroller **402** monitors rotation counter **418** which outputs a signal for each motor rotation (or paper roll **14** rotation, or fraction thereof). When rotation
15 counter **418** generates a predefined number of rotation signals, microcontroller **402** disengages relay **410** thereby removing power to motor **408**. Thus, one of ordinary skill in the art will recognize that the length of paper that is dispensed can be controlled by manipulating the predefined number of rotation signals microcontroller **402** looks for (i.e.
20 the value at which microcontroller **402** turns off motor **408**).

Before engaging relay **410**, microcontroller **402** checks the status of Delay timer **421**. The purpose of delay timer **421** is to prevent consecutive paper dispensing events until a predefined amount of time elapses. Upon disengaging relay **410** after a paper dispensing event, delay timer
25 **421** is activated. While delay timer **421** is active, microcontroller **402** disables relay **410**. Delay timer **421** is designed to "time out" after a predefined amount of time. Such functionality can be achieved using a count down timer, a count up timer or any other suitable timing technology. For example, delay timer **421** could be set to "time out" ten
30 seconds after activation. For such a configuration, consecutive paper dispensing events could not occur faster than once every ten seconds.

Before engaging relay **410**, microcontroller **402** checks the status of door open sensor **420**. When a user opens front cover **24** to replace paper roll **14** or otherwise service dispenser **10**, open door sensor **420** asserts a door open signal that is sensed by microcontroller **402**. Upon
5 sensing a door open signal, microcontroller **402** disables relay **410** thereby disabling electric motor **408**.

Microcontroller **402** monitors the output of sensor **423**. D.C. voltage sensor **423** monitors the output voltage level of D.C. power supply **414**. If such voltage level drops below a predefined amount,
10 microcontroller **402** asserts a voltage signal to low D.C. supply voltage LED **422**. When such a low signal is asserted, LED **422** will emit light informing a user that the D.C. power source (perhaps a battery) is not providing the proper power to controller **400**.

Microcontroller **402** also monitors low paper sensor **424**. One
15 method of sensing a low paper condition may be accomplished using a mechanical arm that rides on paper roll **14**. As paper from paper roll **14** is dispensed from dispenser **10**, paper roll **14** shrinks in size. Eventually such mechanical arm will activate low paper sensor **424** and a low paper signal will be asserted. When microcontroller **402** detects a low paper
20 signal, microcontroller **402** asserts a signal to low paper LED **426** and LED **426** will emit light informing a user that the paper source is almost depleted.

Attention is now directed to paper type sensor transmitter / receiver **406**. When a user opens front cover **24** to replace paper roll **14** or
25 otherwise service dispenser **10**, open door sensor **420** asserts a door open signal that is sensed by microcontroller **402**. Microcontroller **402**, in turn, activates the transmitter/receiver associated with the paper type sensor transmitter / receiver **406**. One possible embodiment of a paper type sensor transmitter / receiver is an RFID based sensor. Ideally, paper
30 roll **14** is associated with an RFID smart tag. For such a configuration, paper type sensor transmitter / receiver **406** transmits an RFID smart tag

trigger signal and listens for transmissions from RFID smart tags associated with paper roll **14**. At least part of the received smart tag data is stored in a memory associated with microcontroller **402**. Such smart tag data ideally comprises paper type identification information. Such
5 information may be used by microcontroller **402** to automatically configured dispenser **10** operation based on the type of paper inserted into dispenser **10**.

Now referring to Fig. **12**, a network enabled dispenser system **450** is depicted. Multiple dispenser **10** devices are shown all interconnected to
10 remote computer **456** via interface **452** and through wired or wireless communication link **454**. Such communication technology is well known in the art and includes Wi-Fi (wireless fidelity) and Bluetooth.

Interface **452** may comprise a gateway for connecting two otherwise incompatible systems or for simply providing a connection
15 between two compatible systems. As used herein, a gateway is an electronic device that connects two otherwise incompatible systems or that simply provides a connection between two compatible systems. Interface **452** may also be incorporated into remote computer **456**.

For such a configuration, a TCP/IP protocol suite may be
20 incorporated into Interface **452** providing a gateway between remote computers connected to communications link **454** and dispenser **10** devices which ideally enables continuous remote access to such devices.

The gateway may incorporate an HTTP server for accessing data from multiple dispenser **10** devices and for transmission of data to individual
25 dispenser **10** devices.

In the above described system **10** configuration, communications link **406** provides access to a first network (such as the Internet) operating in accordance with a predetermined protocol (TCP/IP is one example). A plurality of dispenser **10** devices may comprise a second network, such as
30 a LAN. A gateway (Interface **452**) operatively couples the first network to the second network. Finally, an HTTP server is embedded in either the

gateway or the plurality of dispenser devices facilitating the transfer of data between the two networks. With such a configuration, one of ordinary skill in the art will appreciate that individual dispenser **10** devices or groups of dispenser **10** devices may be accessed as if such devices
5 were a web site and their information could be displayed on a web browser. Such technology is fully disclosed by Ardalan et al. in U.S. Patent 6,363,057 for use in a system for communicating with electricity meters, which is hereby incorporated by reference for all purposes.

Exemplary algorithms for controlling dispenser **10** are now
10 considered. Such algorithms include a Dispense Paper routine, a Check Dispenser Status routine, and a Paper routine. Ideally, such algorithms, in the form of programming code, would be stored in a nonvolatile memory associated with processor **66** or microcontroller **402**. Hereafter, however, processor **66** will be described as executing the disclosed algorithms.
15 Typically, when dispenser **10** is powered up or reset, after performing the necessary startup routines, processor **66** would access and execute such programming code as required. It should be appreciated, however, that such programming code may be executed by any processor associated with dispenser **10**.

20 Referring now to FIG. **9**, a high level block diagram of an exemplary Dispense Paper routine is presented. Step **500** marks entry into the Dispense Paper routine. At step **502**, the status of dispenser **10** is checked by executing exemplary Check Dispenser Status routine which is described in more detail later. Generally speaking, the Check Dispenser
25 Status routine evaluates the state of the various sensors associated with dispenser **10** and "sets" a Status-Off-Line flag if dispenser **10** is not ready to dispense paper or "resets" such Status-Off-Line flag if dispenser **10** is ready to dispense paper. At step **504**, the value of the Status-Off-Line flag is examined. If the Status-Off-Line flag is set, dispenser **10** is not
30 ready to dispense paper and program control returns to step **502** and the Check Dispenser Status routine is again executed. Such a loop will

continue until the Check Dispenser Status routine determines that dispenser **10** is ready to dispense paper and resets the Status-Off-Line flag.

5 If at step **504**, processor **66** determines that the Status-Off-Line flag is not set (i.e. the Status-Off-Line flag has been reset), program control passes to step **506** where processor **66** checks for a signal indicating that paper should be dispensed. For the disclosed exemplary embodiment, processor **66** checks for a received IR signal having a predefined pattern.

10 If the appropriate IR signal has been received, a rotation counter is initialized (step **510**) and program control passes to step **512** where electric motor **52** is activated. As electric motor **52** turns, paper towel roll **14** turns and the rotation counter is incremented. At step **514**, processor **66** evaluates the rotation counter value to determine if the desired number of rotations has been recorded. If the desired rotation counter value has
15 not been recorded, an optional “watchdog” process may be performed (step **516**).

A “watchdog” process is simply a process designed to prevent endless loops. For example, if electric motor **52** has malfunctioned, the desired rotation counter value will not be reached as electric motor **52** will
20 not turn. For such a situation, and without a watchdog process, the processor **66** will be caught in an endless loop where it continuously checks the rotation counter value. If electric motor **52** is consuming power during such a situation, there will be unnecessary power consumption (particularly undesirable for battery power embodiments) and the electrical
25 components that control electric motor **52** will be unnecessarily stressed reducing product life. Exemplary watchdog processes may include checking for paper movement and monitoring elapsed time. Ideally, when an error condition is detected, the watchdog process would disable the motor drive circuits and report the error condition.

30 After step **516**, program control passes back to step **514** and processor **66** again evaluates the status of the rotation counter value. If

the desired rotation counter value has been recorded, then program control passes to step **518** where power to electric motor **52** is interrupted, a Delay Flag is set, Delay Counter is initialized, and the Status-Off-Line flag is set. Program control then passes back to step **502** and the Check
5 Dispenser Status routine is executed.

Referring now to FIG. **10**, step **530** marks the entry into an exemplary Check Dispenser Status routine. Upon entry into such routine, the status of the Delay Flag is checked (**step 532**). If the Delay Flag is set, then program control passes to step **534** and a delay counter value is
10 examined (**step 536**). If a predefined delay counter value has been reached, then the Delay Flag is reset (**step 540**) and program control passes to step **542**. If, however, such predefined delay counter value has not been reached, the delay counter value is serviced (**step 538**) and
15 program control returns to step **534**. Such delay counter value may be a count down timer, a count up timer, an elapsed time monitor, or any other suitable process for monitoring the passage of time. Exemplary methods of servicing a delay counter value include incrementing a counter value, decrementing a counter value, and updating a time value.

Returning to step **532**, if the delay flag is not set, then program
20 control passes to step **542** and the status of the paper sensor is examined. Such a paper sensor ideally determines when dispenser **10** is out of paper. If the paper sensor indicates that the paper supply in dispenser **10** has been depleted, then the Status-Off-Line flag is set and program control returns to the calling routine (i.e. the Dispense Paper
25 routine). If at step **544** the paper sensor indicates that the paper supply in dispenser **10** has not been depleted, then program control passes to step **548**.

At step **548**, a door sensor is evaluated. Such a door sensor ideally determines when a dispenser **10** access means (such as front
30 cover **24**) has been opened (perhaps to service dispenser **10**). If the door sensor indicates that a monitored access point has been opened, the

Status-Off-Line flag is set and a Paper routine (described herein) is executed. When program control returns from the Paper routine, program control returns to the calling routine (i.e. the Dispense Paper routine).

Returning to step **550**, if the door sensor indicates that no monitored
 5 access points have been opened, program controls passes to step **554**.
 At step **554**, the Status-Off-Line flag is reset (i.e. dispenser **10** is ready to dispense paper). Optionally, a Detect and Issue Warnings routine (not disclosed) may be executed at this point. Such a routine would check the
 10 status of warning sensors, such as low battery, low paper, etc. and issue warnings (such as turning on an LED or transmitting a signal/message to a remote device) when necessary. After resetting the Status-Off-Line flag, program control returns to Dispense Paper routine.

Referring now to FIG. **11**, step **580** marks the entry into an exemplary Paper routine. The general purpose of the Paper routine is to
 15 automatically detect the type of paper inserted into dispenser **10** and automatically configure dispenser **10** according to predefined paper dispensing parameters associated with the detected paper type. Such dispensing parameters may include the length of the paper to be dispensed and/or the delay between consecutive paper dispensing
 20 events. At step **582**, processor **66** activates the paper type sensor's transmitter and receiver and listens for paper information (**584**). For example, if the paper type sensor is an RFID based sensor, an RFID trigger signal is transmitted to trigger RFID smart tag transmissions and a receiver circuit listens for such smart tag transmissions.

25 Such transmissions ideally comprise paper information associated with the type of paper inserted into dispenser **10**. As noted above, such paper information may be used, for example, to determine the length of paper to be dispensed and the delay between dispensing events. Thus, paper information may include two counters values; the rotation counter
 30 value (step **512**) and the delay counter value (step **534**). Alternatively, such paper information may be a simple code that is used to

retrieve/access the appropriate paper type information from a memory associated with processor 66. At step 586, if processor 66 determines that valid paper information has been received, then a Paper-Type-Value is set consistent with the received paper type information. Additionally, a
5 PVR-Flag is set (PVR – Paper Value Received). The PVR-Flag is used to document the receiving of valid paper information.

Returning to step 586, if processor 66 determines that no valid paper information has been received, the status of the door sensor is checked (step 586) in the same or similar manner as is done in step 548
10 (FIG. 10). If the door sensor indicates an access point has not closed, program control jumps back to step 584. If, however, the door sensor indicates that the access points have been closed, program control passes to step 594 and the status of the PVR-Flag is checked.

If the PVR-Flag has been set, program control passes to step 598.
15 At step 598, the paper type sensor transmitter / receiver may be deactivated and program control returns to the calling routine, in this case, the Check Dispenser Status routine.

If, however, at step 594 the PVR-Flag has not been set, program control passes to step 595. At step 595, the paper sensor is checked in
20 the same or similar manner as in step 542 (FIG. 10). If the paper sensor indicates that there is paper in dispenser 10, then an unknown paper type is deemed to have been inserted into dispenser 10. Under such conditions, the paper type value is set to a default value (step 597). Such a default value may simply be the previous paper type value (i.e. no change in
25 value) or it may be a predefined value specifically used for unknown paper types. Next, at step 598, the paper type sensor transmitter / receiver may be deactivated and program control returns to the calling routine. If, however, at step 595 the paper sensor indicates that there is no paper in dispenser 10, the Status-Off-Line Flag is set and program control passes
30 to step 598.

Although the invention has been described above with reference to dispensers which automatically dispense sheet materials with the aid of an electric motor, it will be appreciated that the dispenser could include a manually operated lever or the like for drawing sheet materials off a sheet material roll. In manually operated dispensers with levers, the controller would be arranged to limit the operation of the lever, for example the number of strokes that can be effected or the extent of each stroke (not shown).

An advantage of the dispenser according to the present invention is that it automatically controls the lengths of sheet materials dispensed. Accordingly, there is no need for an operator to adjust the dispenser in order to effect a change in the lengths of sheet materials dispensed. Furthermore, the dispenser is efficient in that it allows for the automatic dispensing of relatively short lengths of more absorbent products, and relatively longer lengths of less absorbent products. Also, the dispenser detects the loading of an unrecognized product, which is usually a less expensive and less absorbent sheet material product, and defaults to a greater length of sheet dispensed. In this way, the dispenser dispenses a single sheet in order to provide user satisfaction in using the single sheet for a hand drying episode, no matter whether a highly absorbent or less absorbent sheet material product is dispensed.

It should be understood that the dispenser of the invention is not limited to the dispensing one type of sheet material, such as paper towels. On the contrary, the dispenser could also be used to dispense various other types of sheet material, such as, but not by way of limitation, facial sheets, bath tissue sheets, wipers, and so forth.

While the present invention has been described in connection with certain preferred embodiments, it is to be understood that the subject matter encompassed by way of the present invention is not to be limited to those specific embodiments. On the contrary, it is intended for the subject matter of the invention to include all alternatives, modifications and

equivalents as can be included within the spirit and scope of the following claims.